U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Fuel Cycle Research and Development

Methods for Metric Use

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Fuel Cycle Evaluation and Screening
Stakeholders Meeting on Evaluation Metrics
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Draft Metrics Summary

- Nuclear Waste Management (5)
  - Mass of SNF+HLW disposed per energy generated
  - Activity of SNF+HLW (@100 years) per energy generated
  - Activity of SNF+HLW (@100K years) per energy generated
  - Mass of DU/RU disposed per energy generated
  - Volume of LLW per energy generated
- Proliferation Risk (3)
  - Maximum FOM_1 (nominal fuel cycle material)
  - Maximum FOM_1 (material with mis-use technology included in the fuel cycle)
  - Maximum FOM_1 (material with clandestine use of any technology)
- Nuclear Material Security (1)
  - Maximum FOM_1 (nominal fuel cycle material)
- Safety (1)
  - Relative Safety Management Challenge for all facilities and processes
- Financial Risk and Economics (1)
  - Levelized Cost of Electricity at Equilibrium
- Environmental Impact (5)
  - Land Use per unit of energy production
  - Water Use per unit of energy production
  - Radiological impact - total estimated worker dose per unit of energy production
  - Chemical impact - chemical hazard index per unit of energy production
  - Carbon impact - CO_2 released per unit of energy production
- Resource Utilization (2)
  - Natural Uranium required per unit of energy production
  - Natural Thorium required per unit of energy production
- Development and Deployment Risk (4)
  - Development time
  - Development cost
  - Compatibility with the existing infrastructure
  - Existence of NRC regulations for the fuel cycle and familiarity with licensing
- Institutional Issues (2)
  - Compatibility with the existing infrastructure
  - Existence of NRC regulations for the fuel cycle and familiarity with licensing

Second Breakout Session Discussion of Metric Application

- To apply a metric in the Evaluation & Screening, several characteristics have to be determined, or evaluated:
  - The nature of the metric score: continuous value, discrete values (‘bins’), ranges, distributions, etc.
  - A ‘utility function’ that defines the importance of differences in the metric score and places the scores onto a consistent numerical range for inter-comparison: linear, log, ‘s’-curve, ‘bin’ values, arbitrary, etc.
  - The relative importance of multiple metrics within a criterion, that can be used to create weighting factors to combine metrics scores into a numerical criterion score.
- Some metrics tend to have obvious choices for the metric ‘shape’, ‘utility’ and relative ‘importance’, others are not so clear. The EST will determine these, and may use sensitivity studies to explore multiple options where appropriate.

The breakout groups may provide input on these features in the second breakout session.

Examples

- Calculated metrics with continuous values tend toward continuous utility functions, such as:
  - "Mass of DU/RU disposed per energy generated" – This can be calculated from data generated for each Evaluation Group. The lowest possible values would be 'zero', and the largest value bounded by a subset of the Evaluation Groups. This can be turned into a simple linear utility function.
- Expert judgment metrics with discrete levels tend toward discrete utility funcitions, such as:
  - "Existence of NRC regulations for the fuel cycle and familiarity with licensing" – This may be an informed judgment for each Evaluation Group. Relative to the reference case – no score can be better, and the precision of judgment is likely to result in a 'few bin' score. The relative importance of the change from one bin to another may or may not be linear.
- Some may have several options:
  - "Volume of LLW per energy generated " – This appears to be a continuous numerical score, and could be scored as such if viable data were available. However, this is likely to be an informed relative comparison to the reference case with significant uncertainty, and thus may be a 'few bin' score. The appropriate relative importance may not be linear.

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Examples